POSSIBILITIES OF EFFICIENT USE OF WOOD WASTE FROM SILVICULTURE AND WOOD INDUSTRY

POSIBILITĂŢI DE UTILIZARE EFICIENTĂ A DEŞEURILOR LEMNOASE DIN SILVICULTURĂ ŞI INDUSTRIA DE PRELUCRARE A LEMNULUI

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Abstract: *The improvement of living standards in the rural areas of our country has the effect of increasing the energy demand meant for both household and agricultural processes. In Romania, the access to centralized thermal energy and fossil fuel (natural gas) distribution networks is limited to urban and adjacent areas. In these conditions, the main sources of energy in the rural areas are the forest fund (firewood). The uncontrolled exploitation of the forest fund as a thermal energy source as well as for industrial purposes (as a raw material in the timber industry) has led, in recent years, to its continuous degradation. Large quantities of waste (mainly sawdust) stored in inappropriate conditions, cause soil and water quality degradation. It is necessary on one hand to use new thermal energy generation sources in rural areas, and on the other hand, to use wood residues from forestry exploitation. The present paper evaluates the energy potential from wood residual products (mainly sawdust) ant the potential use as a thermal energy source for rural areas. This evaluation is meant to be a useful tool for rural areas inhabitants to increase the degree of utilization of potential energy sources witch are already available in these areas and to reduce the costs for thermal energy generation.*

Rezumat: *Creşterea nivelului de trai în zona rurală a ţării noastre are ca şi efect creşterea necesarului de energie în cazul utilizatorilor casnici. În România accesul la sistemele centralizate de furnizare a energiei termice sau la reţelele de combustibili fosili (gaze naturale) se limitează în principal la zonele urbane şi arealul adiacent acestora. În aceste condiţii principala sursă de energie termică în zona rurală este fondul forestier, respectiv lemnul de foc. Utilizarea necontrolată a fondului forestier atât ca sursă de energie termică, cât şi pentru scopuri industriale (exploatări forestiere ca materie primă în principal pentru industria de prelucrare a lemnului) a dus, în ultimii ani, la o degradare continuă a acestuia. O altă problemă datorată exploatării necontrolate a fondului forestier o reprezintă cantităţile însemnate de deşeuri (în special rumeguş) rezultate, care depozitate în condiţii improprii poluează solul şi calitatea apei. Astfel se impune pe de o parte utilizarea a noi surse pentru generarea de energie termică în zonele rurale iar pe de altă parte utilizarea deşeurilor lemnoase obţinute în urma exploatării fondului forestier. În lucrarea de faţă se prezintă o evaluarea a potenţialului energetic a deşeurilor lemnoase provenite din exploatarea fondului forestier şi posibilităţile de valorificare a acestora ca sursă de energie termică pentru zona rurală. Acestă lucrare se doreşte a fi un instrument util pentru locuitorii din zona rurală pentru creşterea eficienţei utilizării surselor energetice disponibile în zonă şi implicit scăderea costurilor cu generarea de energie termică.*

Key words: *energy sources, wood waste, sawdust.*
Cuvinte cheie: *surse de energie, deşeuri lemnoase, rumeguş.*

INTRODUCTION

During the last decade, our country has gone through an important period of economical development. This has influenced both the development of rural areas as well as urban ones. In Romania, the rural areas represent an important area of approximately 45% of

the total population (about 10.13 million citizens lives in rural area). The development of rural area has led to an increase of the living standards and as a consequence to an increase of energy needs of the household consumers from these areas. The development of the agricultural sector, which also implied an increase of the number of farms and farming family associations as important consumers of electrical and thermal energy, has also contributed to this boost of energy demand.

The main energy sources used in Romania are oil and its derivatives as well as natural gas. The unconventional energy sources like hydro, solar, wind energy or biomass represent only a small part of the total energy output. Out of a total of 37.9 million toe gross domestic consumption of energy nationwide by 2005, natural gas represented 36.4%, oil and oil products 24.2%, coal 23% while hydro and other unconventional sources of energy represented only 16.4% (fig. 1). But according to the estimates of ANRM oil and natural gas reserves are decreasing. It is estimated that by 2020 these will just 28 million tons of oil and 77 million tons cubic meters of natural gas (fig. 2).

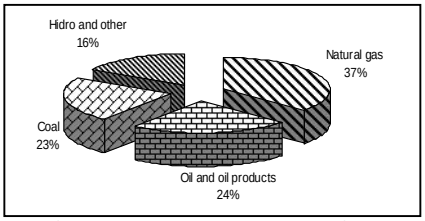

Figure 1. The structure of gross domestic consumption of primary energy in 2005 [3]

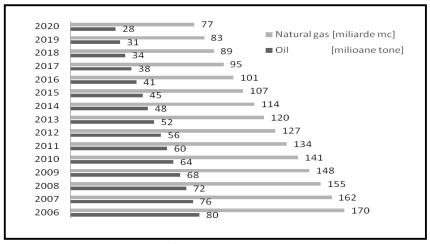

Figure 2.The estimated evolution for oil and natural gas reserves till 2020 [3].

The increase of energy consume together with the decrease of fossil fuels, has led to an augmentation of the dependency for energy imports. Statistical data shows that Romania's dependency on energy imports has increased from 27.1% in 2000 to about 36% in 2005.

Another problem in supplying the required energy in rural areas is the lack of energy infrastructure. According to the National Statistics Institute of Romania, 98% of the rural population is connected to the centralized electricity grid, but only 7% of the households are connected to natural gas distribution networks. In this conditions, the main source of thermal energy for these areas are firewood and wood waste from forestry and wood exploitation. Nowadays, these energy sources are used with low efficiency mainly because of the technology used to convert the energy from waste into thermal energy. That energy sources are used with low efficiency, in Romania, in the present, mainly because the conversion technology are old. Out of the total of conversion technology used in rural area, the stove (with efficiency < 60%) used for fulfil household energy needs (mainly for household heating and food preparation) represent 98%. The rest of the 2% are represented by the boiler with efficiency up to 60%, but that are used only for household heating and hot water preparation.

According to Statistical National Institute [3], in urban area, the percent of household connected to centralized heating grid is about 57,9%. That percent was decreased in last year, mainly because the price of the thermal energy from centralized system was increased; peoples from the urban area begin to us the biomass (mainly fire wood or wood briquettes) or natural gas thermal systems. So, the wood biomass (firewood and wood waste) are important energy sources (especially for thermal energy). In this condition, evaluation of the firewood and wood waste potential (from forestry and exploited wood and manufacturing wood sector) is important for peoples from rural area.

The wood wastes characteristics determinate the choosing of the used possibilities of wood wastes and the optimum energy conversion technology. The information about the energy conversion technology can be an important factor to correlate the conversion technology and the available waste category. So, the people from rural area will can obtain a high efficiency of energy conversion process and the decreasing of thermal energy cost.

MATERIAL AND METHODS

The forest land is the main fire wood and wood waste sources. So, in the 2004 [3], the forest land was about 26,7% (6382,2 thou hectares) from the total surface of the country. The wood biomass potential (about 7594 toe/year or 318PJ/year) can fulfil about 19% from the gross domestic consumption of primary energy in 2000. The wood biomass has a regional distribution on the country area. So, 90% of firewood and 55% of wood waste are located in the Carpathians and Sub-Carpathian and 10% of wood biomass is distributed in the rest of the country. The regional distribution of wood waste potential is in according to the regional distribution of quantity of exploited wood (figure 3).

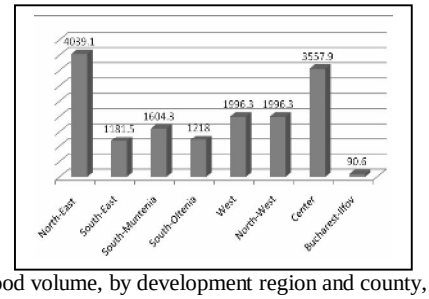

Figure 3. Harvested wood volume, by development region and county, in 2006 [thou m^3], [3].

Regarding the evolution of the wood harvested between 1990 and 2006 (fig. 4), we can observe an increase till 2004 the year when the maximum value of 17,082 thousand cubic meters has been reached.

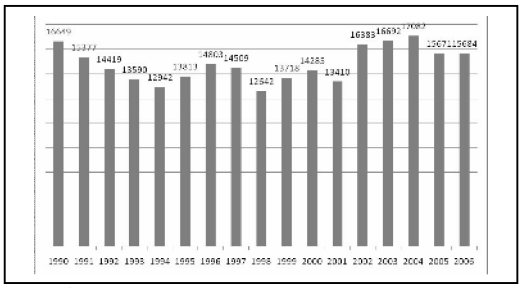

Figure 4. Evolution of harvested wood volume in Romania, 1990-1006 period, [thou m^3]. [3].

After 2004, a decrease in the harvested wood volume has followed till 2006, when a value of 15,684 thousand cubic meters has been recorded. This value is very close to the one from 1999. The quantity of exploited wood has followed the same trend reaching 11,739 thousand cubic meters in 2007. The evolution of the quantity of harvested fire wood and the quantity of wood waste resulted from exploitation activities (bark and technological loses – fig. 5) has evolved in correlation with the quantity of harvested and harnessed wood.

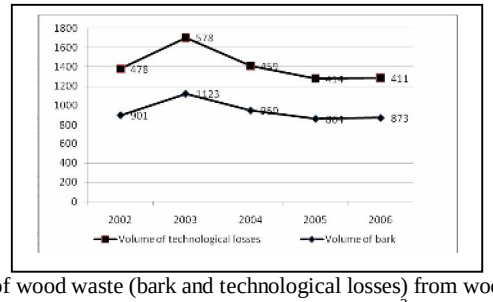

Figure 5. Evolution of wood waste (bark and technological losses) from wood exploited sector in Romania, in 2002-2006 period, [thou m^3]. [3]

From the analysis of these statistical data we reckon that the potential of firewood and wooden residues from forestry and wood manufacturing sector represents about 34% of the yearly exploited wood volume at national level (by year 2006). So we can conclude that Romania has an important energy resource stored in the above mentioned wood waste.

Possibilities of efficient use of wood wastes

Due to variations in water content and chemical composition, for uses of wood wastes as fuel, different efficient methods are us for biomass conversion. These can be named in term of the conversion technology as thermal (direct combustion, gasification, pyrolysis). In general, thermal conversions are used for dry wood waste (under 20% moisture content) and it is used in production of heat, process steam, electricity, gas, charcoal or liquid fuel (the result of catalytic synthesis from gas – methanol or hydrocarbons).

Efficiency of energetic conversion process of wood wastes is about 50%-90% and this percent is variable and it depends of conversion methods, moisture contents, chemical composition and wood wastes fields (chips, bark, and sawdust). For household and small farms from Romania, it can us efficient thermal conversion (direct combustion) to extract the fuel necessary for heating of farms and water warm.

Thermal conversion have two steps: primary conversion (conversion of raw material in fuel – processing, thermo-chemical transformation, psychical transformation, biochemical transformation) and secondary conversion (fuel conversion in energy - heat, mechanical, electrical and combustion of energy) – figure 6.

In present, in Romanian rural area direct combustion is used with very low efficiency (under 50%), because the technology is old and it has low efficiency. The main fuel in this case is firewood. But because Romania has a very good theoretical potential of wood waste and this is found in rural areas, farmers can use wood waste like fuel, very easy and very efficient with low cost for investment. This thing is possible if they use efficient conversion methods and new technologies with high efficiency. The briquetting of wood waste is another method used to increase the energetic efficiency of wood waste utilization. So, it can be manufacture the wood pellets or briquette and that can be us as a fuel in conventional stove, but with highest conversion efficiency.

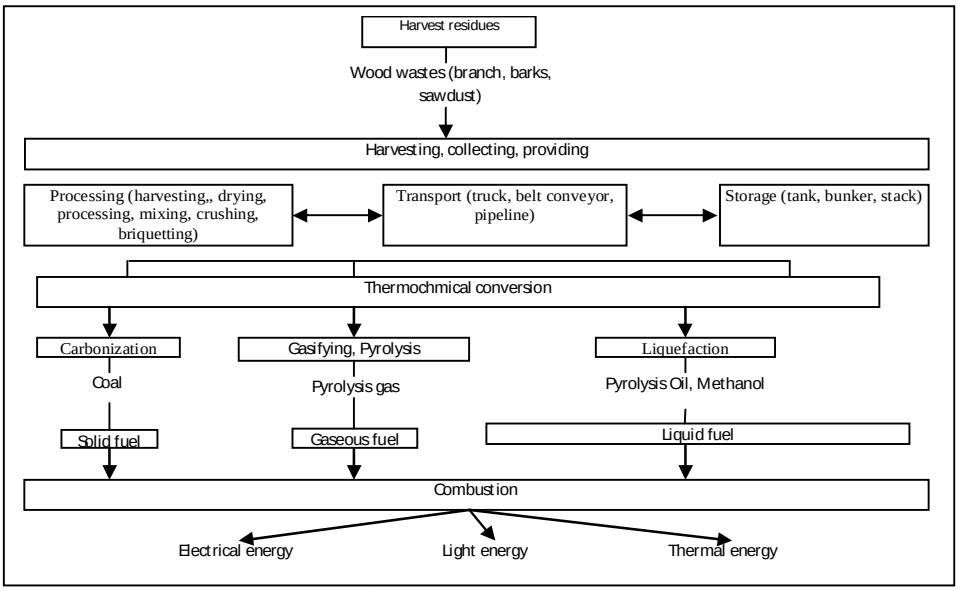

Figure 6. Diagram of conversion efficient method of wood waste.

Wood wastes, besides using in solid form, can be converted into gaseous form through *gasification* route. The producer gas can have and use for thermal application or for mechanical/electrical power generation. The producer gas obtained by the process of gasification can be used in dryers, kilns and boilers. Drying is the most important process in beverage, medicinal plant and spices industry. In the case of kilns, gasification could be suitable for such applications, which provides a better option of regulation the thermal environment (800 - 900ºC).

RESULTS AND DISCUSSIONS

The objective of the application is the determination of wood wastes quantity necessary for fulfil a household thermal energy needs. A mathematical method is used for household energetic needs determination [1]. The input data are showed in table 1. Using the input data and the mathematical method was determinate the thermal energy need for a household heating and hot water preparation. The characteristics of used wood wastes are showed in table 1.

The quantity of thermal energy needs is 18,018kWh or 64,86MJ. That are equivalent with 1,67 l Diesel or 1,56 m^3 natural gas. So, the quantity of wood waste needs for fulfitt household needs (depend on the water content) are: M_1 = 4,98kg (w = 15%, η = 77%); M_2 = 6,63 kg (w = 30%, η = 73%); M_3 = 11.20 kg (w = 50%, η = 65%). Analyzing the results data can be conclude that the wood wastes are viable energy sources for people from rural area, if they us the conversion technology with more then 60% efficiency.

CONCLUSIONS

In Romania, the access to centralized thermal energy and fossil fuel (natural gas) distribution networks is limited to urban and adjacent areas. In these conditions, the main sources of energy in the rural areas are the forest land (firewood). From the analysis of these

statistical data we reckon that the potential of firewood and wooden residues from forestry and wood manufacturing sector represents about 34% of the yearly exploited wood volume at national level (by year 2006). So we can conclude that Romania has an important energy resource stored in the above mentioned wood wastes.

Table 1

Input data used for calculation a household thermal energy needs

Input data need for house heating needs determination			
House characteristics	Value	House characteristics	Value
Walls:		Ceiling:	
House perimeter [m]	40	Ceiling type	Terrace
Walls height [m]	2.5	Total surface of ceiling [mp]	100
Material of structure layer	BCA	Thickness of structure layer [m]	0.250
Thickness of structure layer [m]	0.4	Insulation type	Polystyrene
Insulation type	Polystyrene	Thickness of insulation layer [m]	0.05
Thickness of insulation layer [m]	0.1	Thickness of hydro insulation layer [m]	0.01
Floor:		Windows:	
Floor type	Without cellar	Total windows surface [m]	10
Total surface of floor [mp]	100	Windows type	single glass
Thickness of structure layer [m]	0.250		
Type of secondary layer	Wood		
Thickness of secondary layer [m]	0.01		
Thickness of hydro insulation layer [m]	0.025		
Input data need for water heating needs determination		Input data need for ventilation needs determination	
Number of persons	4	Thickness of insulation layer of walls [cm]	10-15
Temperature of hot water	60		
Inside temperature [°C]	20	Outside temperature [°C]	-10

Wood wastes characteristics [4]			
Wood waste type	Moisture Content, w [%]	Gross Heating Value [MJ/kg]	Boiler Efficiency, η [%]
Wood and bark	15	16,92	77
	30	13,40	73
	50	8,91	65

Due to variations in water content and chemical composition, for uses of wood wastes as fuel different efficient methods are used for biomass conversion. In present, in Romanian rural area direct combustion is used with very low efficiency (under 50%), because the technology is old and it has low efficiency. But because Romania has a very good theoretical potential of wood wastes and this is found in rural areas, farmers can use wood wastes like fuel, very easy and very efficient with low cost for investment. This thing is possible if they use efficient conversion methods and new technologies with high efficiency.

According to application results we can conclude that the wood wastes are viable energy sources for people from rural area if they us the conversion technology with more than 60% efficiency.

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